December 15, 2000

Alan C. Lloyd, Ph.D., Chairman
Air Resources Board
2020 L Street
Sacramento California 95812

Dear Dr. Lloyd:

Subject: Need to Increase T50 Cap to Prevent Gasoline Supply Shortage

Following my testimony at the November 16, 2000 Air Resources Board Meeting to Consider the Adoption of Follow-Up Amendments to the CaRFG3 Regulations you requested additional data. This document contains the propylene, butylene and alkylation capacity data you requested.

As you may recall from my testimony, I told the Board that I was concerned that the LA Times October 15,2000, article “State Barreling Toward Fuel Shortage” was on target. I based my concern on my opinion that the C7 Alkylate that California seemed to be relying upon to replace MTBE was not going to be available. I recommended that the Board increase the maximum allowable temperature at which 50 percent of the California Phase 3 reformulated is evaporated (T50) in order to allow gasoline producers to substitute C8 alkylate in its place. With the exception of higher distillation temperatures, the properties of C8 alkylate which is made from butylene and isobutane are similar to those of C7 alkylate which is made from propylene and isobutane. Also, with the exception of T50, the properties of C8 alkylate are better that the CaRFG3 flat limits. As illustrated in Figure 1, when C8 alkylate or isooctane is added to gasoline meeting the CaRFG3 flat limits the Predictive Model indicates the resulting gasoline will have less emissions than a gasoline the just meets the standards. Therefore, to reduce the probability of a supply shortfall California should raise the T50 cap from 220ºF to 240ºF and let the gasoline producers use the Predictive Model to offset the negative impact of the higher T50 by adjusting other gasoline properties.

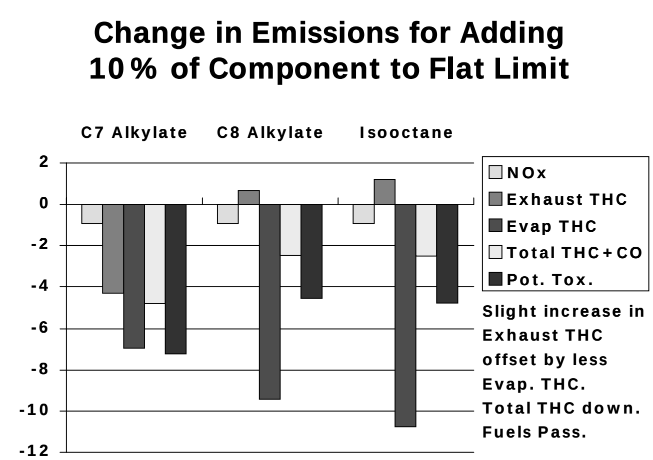
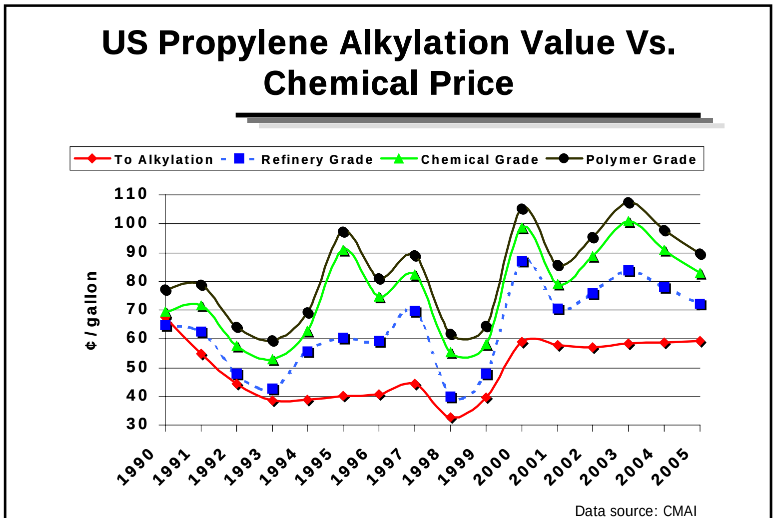


Figure 1

I apologize for taking so long to get back to you with the data. However, it took a while to find current data from a reliable source. The data I am including in this document is based upon work done by Chemical Market Associates, Inc. (CMAI). Because we have a client in common they have given ***A 2nd Opinion**, Inc.* (A_2O) permission to provide some macro supply/demand data in this document. For more details on how the macro supply demand data and price forecasts were developed you or staff will need to contact CMAI’s Christopher Geisler at 281-752-3262.

Price Drives Propylene to Petrochemicals

Figure 2 is a plot of historical and forecast propylene prices and the value of propylene as an alkylation feedstock. Not since 1990 has the value of propylene to alkylation approached its value as a petrochemical. This is why propylene is migrating from fuels to petrochemicals.



Data source: CMAI

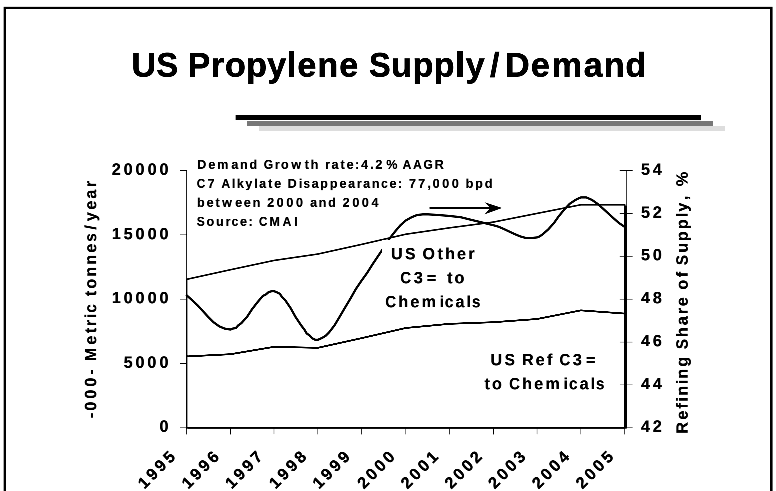
Figure 2

Propylene uses

Table 1 lists the major propylene derivatives, their share of the world propylene market and their typical end uses:

Table 1

Major Propylene Derivatives	**World Propylene Consumption (% of Total)**	**Typical Derivative End Uses**
Polypropylene	61	Plastic films, fibers, packaging
Acrylonitrile	11	Acrylic fibers, ABS resins, nylon
Propylene Oxide	8	Antifreeze, polyurethane foams
Cumene	3	Epoxy resins, polycarbonates
2-Ethylhexanol	5	Plasticizers, coatings
Butanol	4	Plastics, solvents
Isopropyl Alcohol	2	Acetone, solvents, pharmaceuticals
Oligomers	3	Gasoline, plasticizers, detergents
Others	3	Various applications



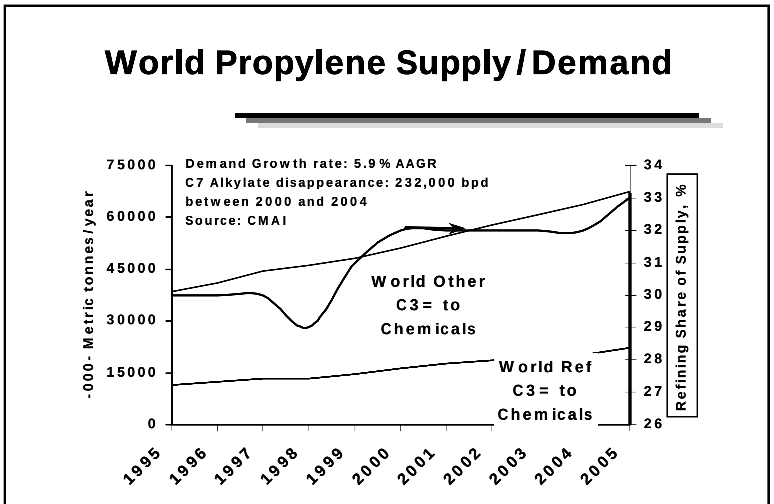
Data source: CMAI

Figure 3

It is not surprising that with this many uses propylene demand is expected to grow at 5.9 percent per year worldwide. In the US where the market is a little more mature, the growth rate is expected to be only 4.4 percent per year.

Propylene Supply Sources

Figures 3 and 4 show the propylene demand trend for the US and the World along with the refining industry's market share of supply. Propylene does not occur



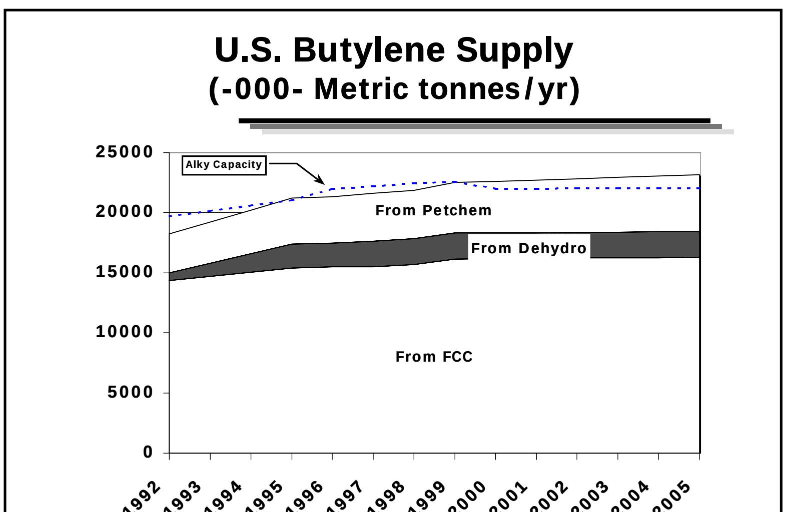
Data source: CMAI

Figure 4

naturally. 98% of the world's propylene comes from either ethylene plant co-product or petroleum refining. In the world, refineries provide 31% of supply while in the US refineries provide over half of the supply. The projected demand growth, which is consistent with past trends, will strain both industries' ability to produce propylene. If the ethylene industry tries to use a heavier feedstock to make more propylene, ethylene production will decline. Most refiners, especially during the summer months when gasoline demand peaks, are maximizing cracking operations and light ends recovery. Therefore, while they could theoretically increase propylene production, they will have to debottleneck equipment first. The variation in supply share is usually caused by the startup of new ethylene cracker capacity with the refining sector being the swing producer. The trend of more propylene migrating from refining to petrochemicals is expected to continue to grow at 2.7%AAGR in the US and at 6.5%AAGR Worldwide. Thus the petrochemical demand for propylene is expected to tighten C7 alkylate (which is made from propylene and isobutane) supply as California's need for a light but low vapor pressure paraffinic gasoline blendstock to replace MTBE and blend off ethanol's high vapor pressure increases.

Butylene Supply Exceeds Alkylation Capacity

Figure 5 is a summary of U.S. butylene supply. If we add up all the butylene supply from refining, petrochemicals and on purpose production in dehydrogenation units, it exceeds the nation's capacity to convert it to alkylate. To state it another way, unless butylene is used to make something else, there is no capacity to alkylate propylene to make the C7 alkylate that California's refining models prefer.



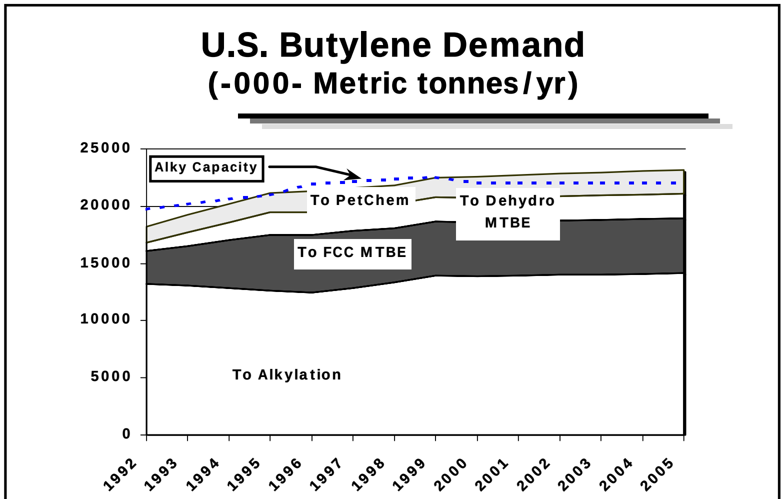
Data source: CMAI

Figure 5

Non-fuel Butylene Uses

Fortunately there are other uses for butylenes. There are two types of butylenes. A branched chain olefin known as isobutylene and a less reactive straight chain olefin known as normal butylene. Normal butylene is also divided into Butene-1 that has the double bond between the first and second carbon atoms and Butene-2 that has the double bond between the second and third carbon atoms. Butene-2 also has cis and trans isomers but, I do not remember the difference but it is not important for this discussion. Figure 6 summarizes US butylene demand.

Isobutylene is more reactive than normal butylene and in used in the manufacturing of butyl rubber for use in tires and hoses. It is also an intermediate in the manufacturing of catalysts, lube oil additives, antioxidants and specialty resins. Isobutylene is also used to make Diisobutylene, Polyisobutylene, Methyl Tertiary Butyl Ether (MTBE) and alkylate.



Data source: CMAI

Figure 6

Diisobutylene is a raw material for surfactants, dispersants, rubber processing chemicals and organic intermediates. It is also an enabler for addition, substitution and oxidation reactions. If Diisobutylene is hydrogenated to saturate the double bond, it forms isooctane a key component of C8 Alkylate.

Polyisobutylene is used in industrial specialty applications as an intermediate for lubricant oil and fuel dispersants. End-use market applications include surfactant hydrophobes, oil field completion fluids and paper sizing compounds.

MTBE is of course a high-octane clean-burning motor fuel component that is being removed from California's gasoline supply and alkylate is a clean-burning paraffinic gasoline component that along with ethanol will be needed to replace MTBE. It also is the largest current use for isobutylene.

Normal butylenes are less reactive than isobutylene. Their major end-use is alkylate. However, butene-1 does have some petrochemical applications as a co-monomer in the production of linear low-density polyethylene, high-density polyethylene and other applications such as the production of higher alcohols.

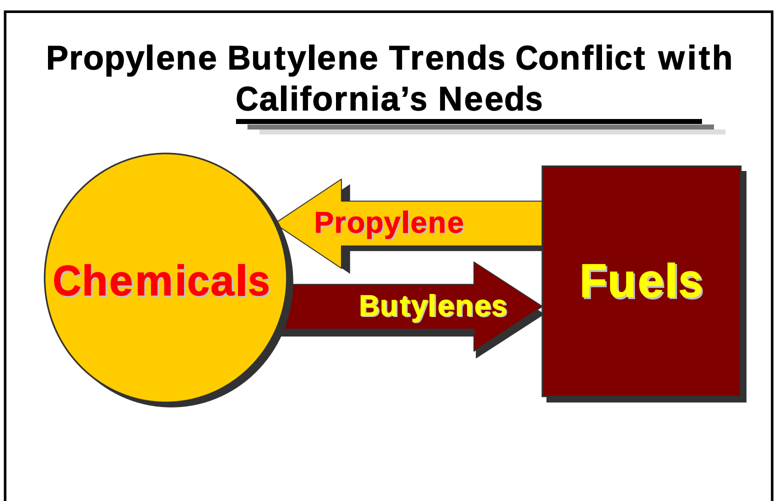


Figure 7

Despite all of these applications, the demand for butylenes in non-motor fuel end-uses is about one twelfth of butylene supply and one eighth of the petrochemical propylene use and is growing at only 2%AAGR. The production of butylenes in the petrochemical sector (excludes isobutylene made for MTBE is a little over twice the petrochemical demand. The volume of butylenes that migrate from petrochemicals to refining is growing at 2.3 %AAGR. Thus the propylene and butylene trends illustrated in Figure 7 conflict with California's needs.

Will the Alkylate be there?

The earlier work on alkylate supply projections for California seemed to focus on what it would cost to buy alkylate away from other fuel uses. C7 alkylate has less octane and a higher vapor pressure than C8 alkylate. Therefore, it seemed reasonable that it could be either segregated or fractionated from C8 alkylate and sent to California where the T50 specification made C7 alkylate worth more than C8 alkylate. In Figure 6 data is rearranged to focus our attention on the question: "will C7 alkylate be available?"

In Figure 8, butylenes supplied from various sources are compared with US alkylation capacity. The surplus butylenes from petrochemicals operations have historically found their way into alkylation or MTBE units. The butylenes produced in the refinery FCC units are either alkylated or converted to MTBE. The on purpose butylene production from dehydrogenation units mainly is used to make MTBE. The leftover alkylation capacity is shown at the bottom of the chart as propylene (C3=) capacity. During the 1990's the expansion of alkylation capacity did not keep up with butylene production capacity. As long as MTBE demand and propylene petrochemical use was growing, this was not a problem. But it will be a problem in the future.

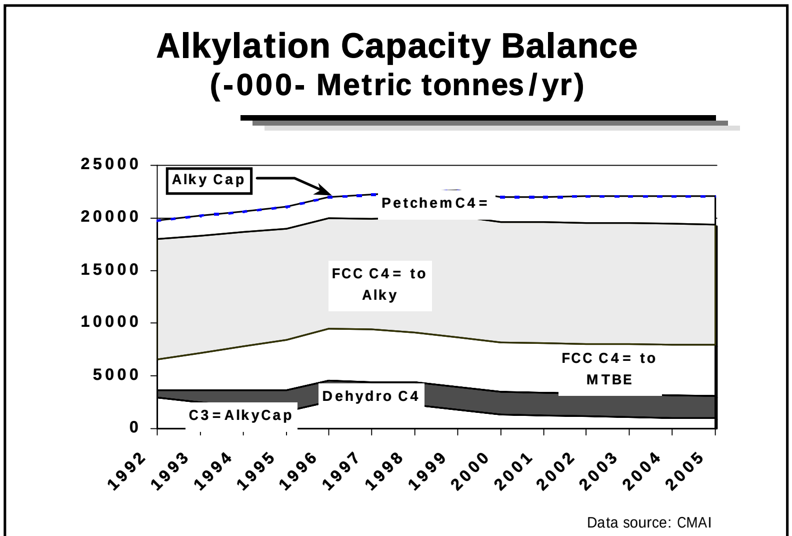


Figure 8

Today MTBE is used throughout the country and the refining industry's capacity to alkylate propylene is represented by the line between "FCC C4= to MTBE" and "FCC C4= to Alky". Under these circumstances, the capacity to produce C7 alkylate decreases only slightly and it is reasonable to ask what does it take to buy C7 alkylate away from another refiner's gasoline pool. However, if MTBE is banned outside of California the story changes. The Dehydro butylenes will not be made unless the price differential between butane and gasoline widens. But, the FCC and Petchem butylenes still need a home. Vapor pressure regulations preclude the use of more butylenes in gasoline during the summer months and the fact that they are olefins further reduces their value relative to butane. Thus the refiner's choice is to either alkylate or not make them. Not making them by cutting conversion at the cracking facilities is seldom economic. Therefore, they will need to push propylene out of alkylation. This will in turn depress the value of propylene and cause olefin producers to select a lighter feedstock slate that makes less propylene in the petrochemical sector and buys more from the refining sector. This will reduce the availability of C7 alkylate while increasing the availability of C8 alkylate.

This situation creates a quandary for California. If California chooses not to relax the midpoint specifications and chooses to continue to rely on C7 alkylate imports for 7 to 11 % of their gasoline supply they risk a significant price spike. According to the Department of Energy's price demand elasticity factor, prices would have to double to suppress demand enough to offset a 3% supply shortfall. Politically the potential price increase is not an acceptable answer. California cannot control the C7 alkylate supply so they should consider other options.

One option could be to support the continued use of MTBE everywhere except California. This would help assure that there was capacity to alkylate propylene to make C7 alkylate that California's modeling efforts have preferred to import. This option has a consistency problem and given the current anti-MTBE sentiment may also be out of California's control.

An option that is totally within California's power is to adjust gasoline midpoint specifications to accommodate the heavier, but still clean burning, C8 alkylate. Regardless of MTBE's fate, this increases the imported blendstock options for California. Raising the maximum to 240^{o}F is a no-brainer. It gives refiners more flexibility without harming air quality. (See Figure 1.) Raising the flat or average limit is more difficult because some other gasoline parameter must be made more restrictive if we are to preserve air quality. But, California's own simulations show that California becomes more self sufficient in gasoline supply if the midpoint is increased. Therefore, CARB should study that option.

The auto industry will oppose this proposal. They are dedicated to a low midpoint specification. But, remember, they have the sulfur level they want, the ninety-percent point they want as well as the aromatics and olefins levels they want. The refining industry should support the higher midpoint specification because it will give them more flexibility. However, some refiners may oppose it because a tighter supply situation will lead to higher margins. The ethanol industry should appreciate having the C8 alkylate's lower RVP available to blend off ethanol's relatively high blending RVP. Finally the people of California should appreciate having a more reliable gasoline supply and the lower prices that come with it.

Summary

The petrochemical demand for the propylene used to make the C7 alkylate is growing at such a rate that it will restrict the supply of the C7 alkylate that California's models show it needs to replace MTBE. If MTBE use is restricted elsewhere in the United States, isobutylene currently being converted to MTBE will push more propylene out of alkylation and make the C7 alkylate supply situation even tighter. The C8 alkylate or isooctane that will be made from the displaced isobutylene is similar to C7 alkylate except for higher distillation temperatures. Adding C8 alkylate or isooctane to California's Phase 3 gasoline will make the gasoline cleaner burning than the standard. Therefore, to provide gasoline producers with more flexibility and to provide California consumers with a more secure gasoline supply and the lower costs that usually accompany an adequate supply situation. CARB should immediately raise the T50 cap to 240^{o}F and consider raising the flat and average T50 limits.

For ***A 2nd O****pinion, Inc.*

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